廃棄貝殻を用いて地盤改良に関する研究
The Utilization Shell Husks Waste as Recycle Aggregate for Ground Improvement

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Introduction

Waste shell husks have been posing a threat to environment all over the world. The cost to dispose waste shell is expensive and, in Japan, it is estimated that nearly 32 million US dollars were spent every year to dispose 151,000 tons abandoned shell husk waste [1].
In this study, shell husks are mixed with soils to evaluate its shear strength properties using triaxial tests. The triaxial test is the most reliable methods available for determining shear strength parameters under different drainage condition [2]. The new shear strength properties are then used for a numerical experiment of a geotextile reinforced embankment, hoping to establish a design procedure for the new construction material.

Materials and Methods

Mactridae shell husk, shown in Figure 1, was selected as a coarse aggregate agency for the new construction material. Four different percentages of the shell husk (0%, 10%, 20%, and 30 % by mass) were used in this project to study their responses of shear strength.

Figure 1 Shell husk waste.

The samples were manually compacted inside the mold with 12.5cm in height and 5.0cm in diameter.

Experimental Procedure

After the above sample preparation, a triaxial chamber is assembled after soil specimen is sealed by the rubber membrane (Figure 2). The hydrostatic chamber pressure is applied using the air channel on the top cap while the air release valve closed. The confining pressures used in this study are 50kPa, 100kPa, 150kPa, and 200kPa. During the test, water valve is kept open to simulate a drained condition during the test [3].

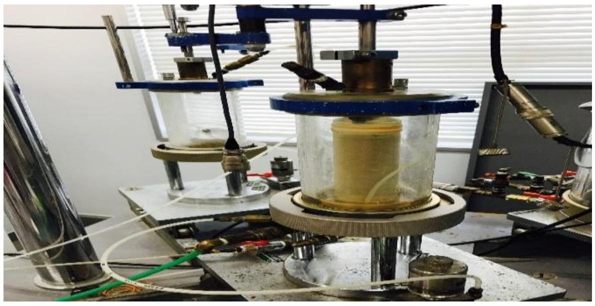

Figure 2 Setup of a Triaxial test.

Results and Discussion

Figure 3 presents the relationship between the cohesion and the shell husk % of the new construction material. The internal friction angle of the new construction material is shown in Figure 4 for various shell husk %.
A trial numerical models are developed to simulate the stability of a vertical geotextile reinforced wall with soil-shell husk backfill. The wall is of 3 m in height (H) with 5 layers of geotextile and equal vertical spacing of 0.5 m. The length of geotextiles is 2.1 m which is about 0.7H. 10% shell husk percentage is chosen as the material input. The problem is qualitatively examined with the problem mesh in Figure 5. Figure 6 shows the soil displacement pattern, whilst the cable (geotextile) displacement and normal pressure distribution (cable soil interface) is presented in Figure 7. The potential failure mechanism for the problem is shown in Figure 8. A safety factor of 4.57 is obtained for the problem. It is encouraging to see these results which have qualitatively shown the success of the trial development of the numerical experiment.

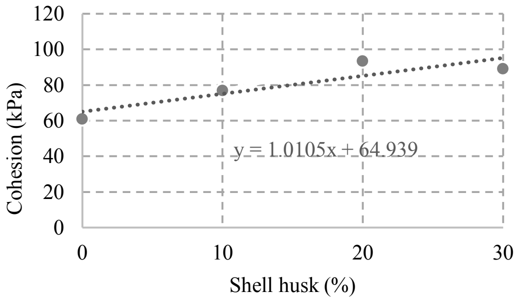

Figure 3 Cohesion vs. shell husk %

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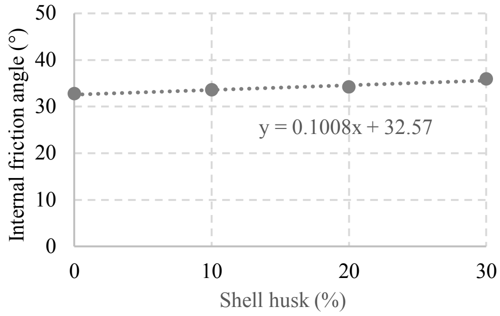

Figure 4 Internal friction angle vs shell husk %

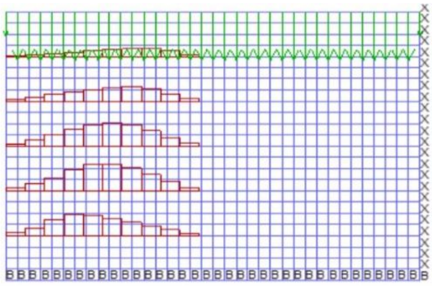

Figure 5 Mesh, boundary condition, apply pressure, and the axial force distribution of the geotextile

Conclusions

The experimental study of the new construction material (i.e. soil - shell husk mixture) has indicated that approximately 10% - 15% increase of the shear strength parameters (c and φ) can be achieved by increasing the shell husk percentage to 30%. This finding was then input to a trial numerical model to analyze the safety factor of a geotextile reinforced wall. It is encouraging to see, qualitatively, the successful implementation of the trial numerical experiment. This project has paved the road for a number of future research work in relation to the construction and design of soil structures such as agriculture roads and retaining wall backfills using the new construction material.

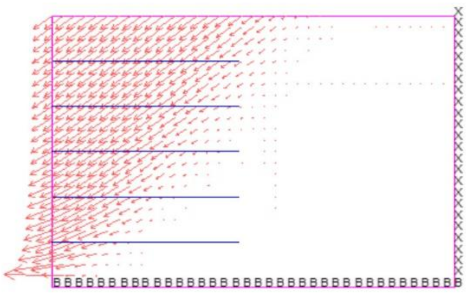

Figure 6 Geotextile and soil displacement pattern

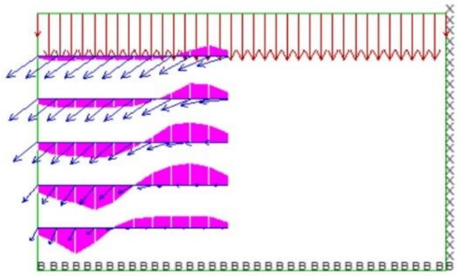

Figure 7 Displacement and normal pressure distribution of the geotextiles (cable plot)

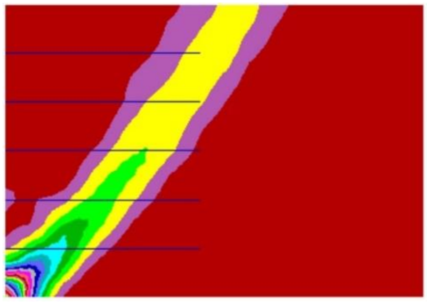

Figure 8 Plot of shear strain rate indicating a potential failure mechanism

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[3] JGS 0524: Method for consolidated-drained triaxial compression test on soils, 2014.

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